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Center: Consortium for Materials Development in Space
The University of Alabama in Hunstville (UAH)

Task Name: **"Wake Shield"**

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Introduction

Progress has been made on the modeling of the flow field around a wake shield using a recently obtained code based on the Mote Carlo method. The code is the original work of Dr. Bird of The Department of Aeronautical Engineering, University of Sydney, New South Wales, Australia. Dr. Karr has been in close communication with Dr. Bird and advice on needed changes has been obtained. The following discusses the code, the modifications needed, and the plans for making the changes.

The direct simulation Monte Carlo method is a method for solving the Boltzman Equation using an approximation to the collision integral term. The collision integrand is evaluated for randomly selected values of its arguments and the summation will approach the integral for large enough samples. The collision effects may be modeled for either hard sphere or various power law potentials. The convective side of the Boltzman equation is approximated over a time step using a simple trajectory calculation of molecules as they travel through the domain of interest. The Bird code is widely use in rarefied gas

flow calculations and should be useful in the simulation of the wake shield flow problem. The boundary conditions for the code are the changes required for our application.

The domain boundary conditions are of importance in the application of the Bird code in order to properly represent the effect of the gas-surface effects on the shield. The results we have obtained to present show a region of enhanced density in front of the shield due to the thermalization of ambient molecules that hit the shield. After hitting the shield the velocity is likely reduced to a much smaller value than the 8-km/s incident value. This reduction in velocity coupled with possible directional effects of the surface interaction makes the shield boundary an important surface in the calculation. Presently we use a very simple model of the gas-surface interaction and see a considerable build-up of molecules in front of the shield. This region of enhanced density interacts with the incident flow to cause scattering into the high vacuum region behind the shield. Since this effect could be a limiting factor on the vacuum that can be obtained, we have begun to modify the Bird program to take into account more realistic gas-surface interaction results that have been described in previous reports.

Our plans for modifying the Bird code will require that the method used in the calculation of the effect of collision with the solid boundaries be changed. We are presently working with Dr. Bird to best handle these changes. The work will require that the experimentally determined interaction be modeled in a parameter form that can be randomly sampled. Work has begun on this effort and results should be available during the next reporting period.

Another change in the Bird program that is being addressed is the need to give results in the form of directorial flux rather than number density. The use of directional flux is of more importance to the region behind the shield so that the orientation of experiments can be studied. We have discussed this modification with Dr. Bird and expect to have results available by the next reporting period.